The Analysis of the Visually Information Processing in the Brain by Using Magnetoencephalogram

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Abstract MEG(magnetoencephalogram) is the powerful technique for the analysis of brain activity. The magnetic signal doesn't reduce in a brain, and we can obtain the accurate information about the position of the signal source by using MEG. Our aim of this study is the analysis of the stereoscopic effect in the brain. In this report, we will talk about our MEG measurement system and our pseudo stereographic pattern which is used stimulation. We will also talk about the characteristics of the MEG which is measured by projection of stereographic pattern, and the result of the estimation of the position of a single current dipole.
Keywords- Random-dot Stereogram, Visual Evoked Potential, Magnetoencephalogram

I. INTRODUCTION

We always live our life depending upon information which is obtained from the circumstances that surrounds us. More than 80% of this information is from our visual sensation, and this is one of the most important sensation for us. So, we are studying and analyzing the sight information processing in the brain by using MEG. Sight information processing includes many items (for example, color, shape, etc) in it's category. We especially direct attention to the stereoscopic effect in the brain and are analyzing about this effect. In this study, pseudo solid pattern is used as a sight stimulation pattern and evoked MEG are measured and analyzed.

II. MEASUREMENT SYSTEM

Neuromag-122 system is used as a MEG measurement system in our research. This system measures the MEG using 122 channels of SQUID sensors which are set on the helmet. Fig.1 shows the outline of our MEG measurement system. In Fig.1 each number means as following.

1. Work station (which controls Neuromag system)
2. MEG measurement system
3. Screen
4. Magnetic shield room
5. Video projector
6. Personal computer (which generate stimulus pattern)
7. Trigger box

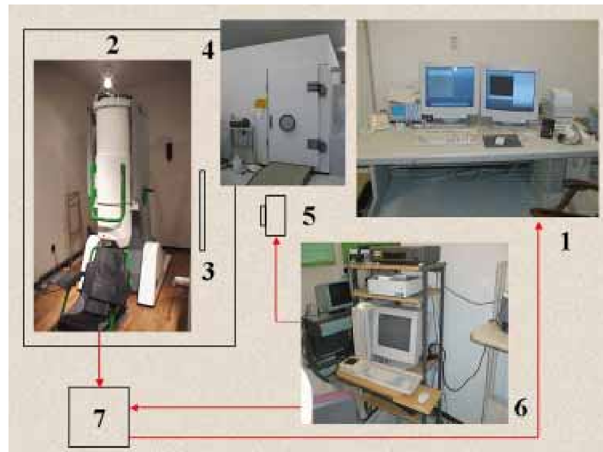

Fig. 1: MEG measurement system

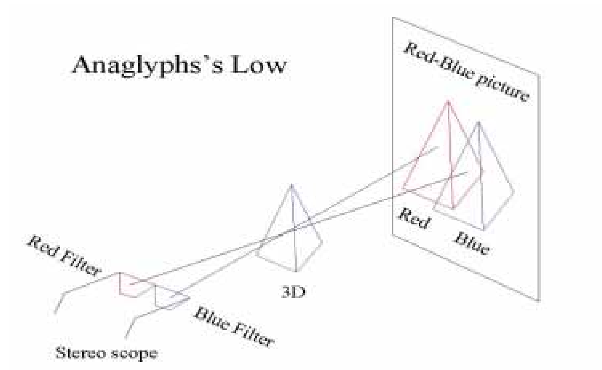

Fig. 2: Outline of the anaglyph method

As shown in this figure, stimulus patterns are generated by graphic system of a personal computer (IBM PC/AT clone). Then, generated patterns are projected on the screen which is set in front of a subject by a video projector which is out of the magnetic shield room. The distance between a screen and a subject is 1m. In our system, MEG is measured synchronously with projection of stimulus patterns by trigger signal which is generated in the personal computer.

III. METHOD

Our brain usually try to generate one image from two images which are obtained from both eyes. This function is said as the fusion. Using this function, we can recognize

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Abstract

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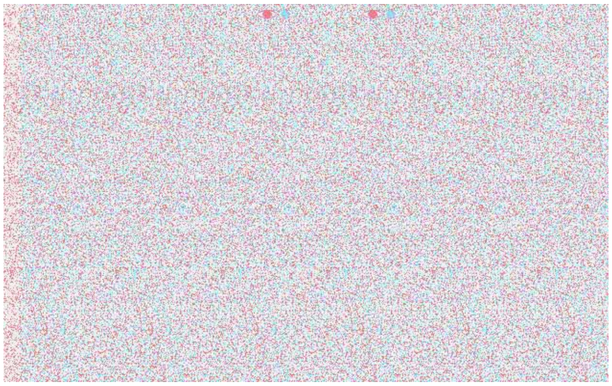

Fig. 3: An example of stimulus pattern

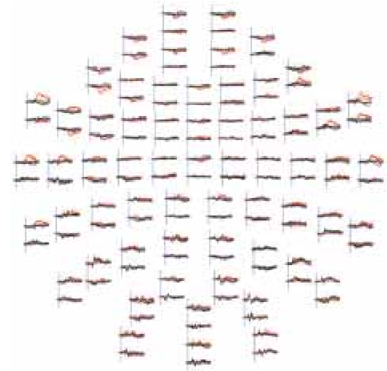

Fig. 4: MEG which were measured under condition (1) and (2)

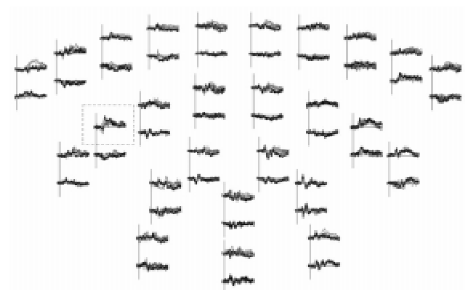

Fig. 5: MEG of lobus occipitalis

stereo pattern. It is said that this function is processed in the optic area of the brain cortex. Our objective is the finding and localizing of the position of the brain which is activated by fusion.

As the method of stereograph, RDS(random-dot stereogram) is popular. However, not all subjects recognize stereo shape by projection of RDS pattern. So, in our system, anaglyph method is used to indicate pseudo solid pattern. A conception of this method is shown in Fig.2 A subject wares the stereo glasses and see the screen at the measurement. One lens of this glasses is colored green and the other lens colored red. The stimulus pattern is composed of red and green colored patterns. Both patterns have same shape and are set small distance apart. A subject looks at this stimulus pattern through the stereo glasses, and then a subject can see the stereo pattern. Distance between red and green pattern is concerned with the depth of pseudo solid pattern.

An example of the stimulus patterns is shown in Fig.3. This picture is composed of red, green and black dots. Usually, we can see this pattern as random dots pattern without stereo glasses. However, we can see the risen square at center of the screen with stereo glasses. We show a subject two kind of pattern alternately. One is the stereogram like Fig.3 and the other is only random dot pattern which doesn't induce a solid shape with stereo glasses. A subject see the image that a square pattern goes up and down at the center of a screen by alternate projection of these two patterns. In our system, two kinds of evoked MEG which are induced by the pattern change (goes up and goes down) are measured and analyzed. In our stimulation, it is impossible to estimate the movement of pattern at the change of stimulus pattern. So, we can evaluate characteristics of the stereoscopic vision without effect of the pattern change.

IV. EXPERIMENT

Evoked MEG of two normal subject were measured. In these case, a stereogram pattern and random dot pattern were projected to a subject alternately. Stimulus period is 1000[ms] and the number of synchronous addition are 100. Obtained MEG were analyzed by using the single current dipole model. Stimulus condition of the measurement is shown as following.

(1) Subject wore a stereo glasses.
In this condition, subjects see two kinds of pattern change. One is the flat to risen square, and the other is the risen square to flat. So, we can get two kinds of evoked MEG.

(2) Subject wore red colored glasses.
In this condition, subjects cannot see the risen square pattern. Because, they cannot see green dots of stimulus pattern. They only feel the slight movement of random dots at the change of pattern.

V. RESULTS

Measured MEG under condition (1) and (2) are superimposed in Fig.4. This figure is a top view image, and upper side of this figure indicates the frontal lobe, and lower side shows the occipital lobe. 4 MEG signals which were measured in condition (1) and 4 MEG signals which were measured in condition (2) are superimposed in each MEG channel of Fig.4. A part of occipital lobe in Fig.4 are enlarged in Fig.5. Characteristic patterns are observed in the area which is surrounded by dotted line in Fig.5. This area is enlarged in Fig.6.

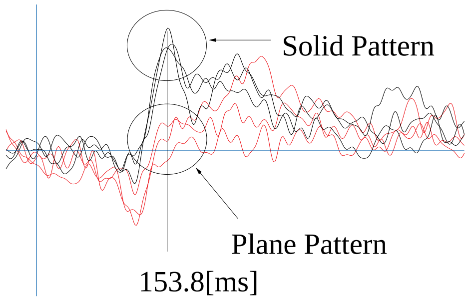

Fig. 6: Characteristic patterns of MEG

Table 1: Amplitude of the 1st positive peak of MEG

	Wave No.	Amplitude [fT/cm]	Average [fT/cm]
Solid Pattern Projection	1	52.0	53.8
	2	54.8	
	3	44.7	
	4	63.9	
Plane Pattern Projection	1	10.6	16.5
	2	17.6	
	3	22.5	
	4	13.5	

VI. CONCLUSION

As shown in Fig.5, at the most part of occipital lobe, we can observe same characteristics in condition (1) and (2). 1st peak was observed after about 130[ms] of stimulation. And after this peak, smaller positive peak was observed. These characteristics were observed all part of occipital lobe. And we think that these characteristics are evoked by a simple movement of the stimulus pattern. However, as shown in Fig.5, clear difference between condition (1) and condition (2) were observed in left side of occipital lobe which is adjacent to temporal lobe where is surrounded by dotted line in this figure. We can see enlarged this area in Fig.6. In this figure, there was a clear positive peak whose latency was about 153[ms] in the MEG which was measured under condition (1). However, we can not observe clear positive peak at the same place (latency is about 153 [ms]) in the MEG which measured under condition (2). Same characteristics were observed at the symmetrical part of right side. The amplitude of these positive peaks of condition (1) and amplitude of MEG which were measured in condition (2) at the same time are shown in Table.. As shown in this table, there is clear difference of amplitude between condition (1) and condition (2). Under condition (2), subjects cannot recognize stereo pattern, because dots which is colored green of stimulus pattern canceled by red glasses. They only feel the slight movement of random dots at the change of stimulus pattern. Therefore, we think that this positive peak is concerned with the recognition of stereoscopic vision. The position of single current dipole which corresponds to first positive peak of MEG (latency = 153[ms]) was estimated and superimposed on a MRI image of the subject. The result of this estimation is shown in Fig.7.

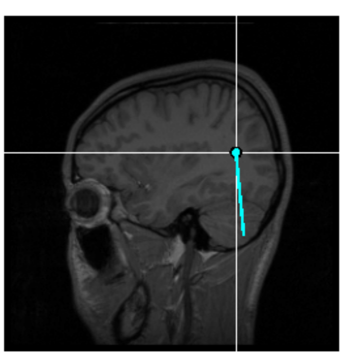

Fig. 7: The result of single dipole estimation

By using pseudo solid pattern, the MEG which was concerned with stereoscopic vision was measured. And a position of single dipole of stereoscopic vision was estimated. Therefore, we've concluded that by collecting a large number of MEG data and by treating them statistically, the position of stereoscopic vision in the brain can become clear.

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